

CLAIMS

I claim:

- 1 1. A magnetic head comprising:
2 a free magnetic layer having two ends;
3 two hard bias layers, each adjoining a corresponding end of the free magnetic
4 layer, and which create a bias magnetic field within the free magnetic layer;
5 a bias reduction layer disposed parallel to the free magnetic layer; and
6 a bias spacer layer disposed parallel to and between the free magnetic layer and
7 the bias reduction layer;
8 wherein the bias reduction layer creates a magnetic field within the free magnetic
9 layer that is directed oppositely to the bias magnetic field.
- 1 2. A magnetic head according to claim 1, wherein the bias spacer layer is comprised
2 of ruthenium or copper.
- 1 3. A magnetic head according to claim 1, wherein the bias spacer layer is comprised
2 of ruthenium having a thickness between approximately 8 and 40 angstroms (Å).
- 1 4. A magnetic head according to claim 1, wherein the bias spacer layer is comprised
2 of copper having a thickness between approximately 2 and 10 Å.

1 5. A magnetic head according to claim 1, wherein:
2 the bias spacer layer includes a bias spacer material and has a bias spacer
3 thickness; and
4 the bias spacer material and the bias spacer thickness are selected so as to produce
5 a negative magnetic coupling between the free magnetic layer and the bias reduction
6 layer.

1 6. A magnetic head according to claim 1, wherein the bias reduction layer is
2 comprised of NiFe or CoNiNb.

1 7. A magnetic head according to claim 1, wherein the bias spacer reduction layer is
2 comprised of NiFe having approximately 80 to 95% nickel.

1 8. A magnetic head according to claim 1, wherein the bias reduction layer is
2 comprised of CoNiNb having between 60 to 85% Co, and between 20 to 5% Ni, and
3 between 25 to 5% Nb.

1 9. A magnetic head according to claim 6 wherein the bias reduction layer is
2 approximately 10 Å thick.

1 10. A magnetic head according to claim 1, wherein:
2 the bias reduction layer includes a bias reduction material and has a bias reduction

3 layer thickness; and

4 the bias reduction material and the bias reduction layer thickness are selected so
5 as to produce a bias reduction magnetic field within the free magnetic layer, wherein the
6 bias reduction magnetic field counteracts the bias magnetic field at positions within the
7 free magnetic layer that are between ends of the free magnetic layer.

1 11. A magnetic head portion according to claim 1, wherein the hard bias layers induce
2 an edge bias magnetic field within the free magnetic layer at the ends of the free magnetic
3 layer, where the edge bias magnetic field is of sufficient strength to stabilize the free
4 magnetic layer even when partially counteracted by a bias reduction magnetic field
5 created by coupling of the free magnetic layer with the bias reduction layer.

1 12. A hard disk drive for reading and writing information in a magnetic medium, the
2 disk drive comprising:

3 a disk having a surface that includes the magnetic medium;

4 a motor coupled to rotate the disk;

5 a slider having an air bearing surface;

6 an actuator configured to hold the air bearing surface of the slider proximate to
7 the surface of the disk;

8 a magnetic head disposed within the slider and forming part of the air bearing
9 surface, wherein the magnetic head includes:

10 i) a free magnetic layer having two ends;

11 ii) two hard bias layers, each adjoining a corresponding end of the free
12 magnetic layer, and which create a bias magnetic field within the free magnetic
13 layer;
14 iii) a bias reduction layer disposed parallel to the free magnetic layer;
15 iv) a spacer layer disposed parallel to and between the free magnetic layer and
16 the bias reduction layer; and
17 wherein the bias reduction layer creates a magnetic field within the free magnetic
18 layer that is directed oppositely to the bias magnetic field.

1 13. A hard disk drive according to claim 12, wherein the bias spacer layer is
2 comprised of ruthenium or copper.

1 14. A hard disk drive according to claim 12, wherein the bias spacer layer is
2 comprised of ruthenium having a thickness between approximately 8 and 40 Å.

1 15. A hard disk drive according to claim 12, wherein the bias spacer layer is
2 comprised of copper having a thickness between approximately 2 and 10 Å.

1 16. A hard disk drive according to claim 12, wherein:
2 the bias spacer layer includes a bias spacer material and has a bias spacer
3 thickness; and
4 the bias spacer material and the bias spacer thickness are selected so as to produce

5 a negative magnetic coupling between the free magnetic layer and the bias reduction
6 layer.

1 17. A hard disk drive according to claim 12, wherein the bias reduction layer is
2 comprised of NiFe or CoNiNb.

1 18. A hard disk drive according to claim 12, wherein the bias spacer reduction layer is
2 comprised of NiFe having approximately 80 to 95% nickel.

1 19. A hard disk drive according to claim 12, wherein the bias reduction layer is
2 comprised of CoNiNb having between 60 to 85% Co, and between 20 to 5% Ni, and
3 between 25 to 5% Nb.

1 20. A hard disk drive according to claim 12, wherein the bias reduction layer is
2 approximately 10 Å thick.

1 21. A hard disk drive according to claim 12, wherein:
2 the bias reduction layer includes a bias reduction material and has a bias reduction
3 layer thickness; and
4 the bias reduction material and the bias reduction layer thickness are selected so
5 as to produce a bias reduction magnetic field within the free magnetic layer, wherein the
6 bias reduction magnetic field counteracts the bias magnetic field at positions within the

7 free magnetic layer that are between ends of the free magnetic layer.

1 22. A hard disk drive according to claim 12, wherein the hard bias layers induce an
2 edge bias magnetic field within the free magnetic layer at the ends of the free magnetic
3 layer, where the edge bias magnetic field is of sufficient strength to stabilize the free
4 magnetic layer even when partially counteracted by a bias reduction magnetic field
5 created by coupling of the free magnetic layer with the bias reduction layer.